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ABSTRACT

This publication, the first in a series on theory, innovation, and practice in andragogy, is a reproduction of two papers first published in 1971 by Coolie Verner and Catherine V. Davison. The first paper in this booklet explores psychological factors in adult learning and instruction, while the second discusses physiological factors. In the five sections of the first paper, the authors discuss learning and instruction as processes, the stages and conditions of learning and instruction, remembering and forgetting, and tips for designing and managing instruction, and include a list of references. The physiological factors explored in the second paper are the aging process, vision, hearing, learning, and performance (psychomotor skills and verbal communication). Their impact on adult learning is the focus of the study, which also includes a summary and references. (KC)

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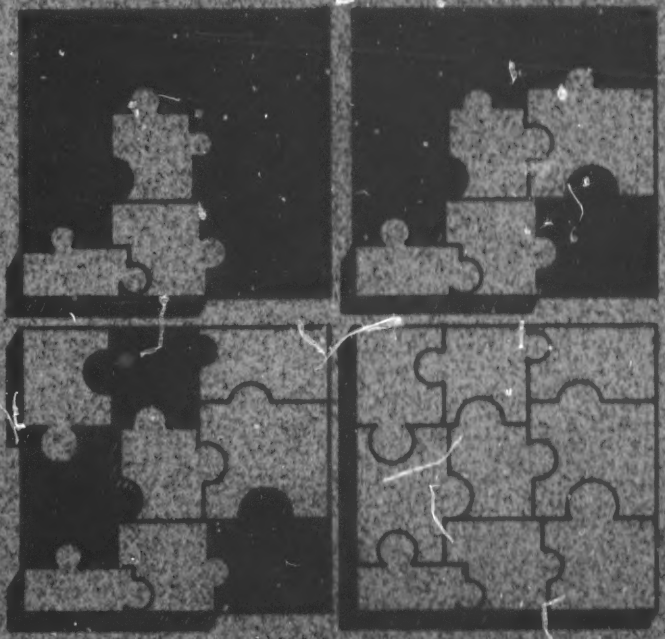
FACTORS IN ADULT LEARNING AND INSTRUCTION

Felix Adam and George F. Aker, Editors



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FOREWORD

This, the first publication in our series Theory, Innovation, and Practice in Andragogy, is a reproduction of two papers first published in October 1971. We have chosen to initiate the series with this work because of our deep and everlasting respect and affection for its senior author, Professor Coolie Verner, a personal friend, colleague, and world-renowned contributor to several disciplines, not the least of which is the field of adult education.

This publication is a small but fitting tribute to Coolie Verner, scholar of early American history, cartography, the sociology of innovations, the psychology of learning, and adult education method and technology. Professor Verner is the man who created the graduate programs in adult education at Florida State University in 1953 and at The University of British Columbia in 1961, the man who was about to serve his second term as Visiting Professor of Andragogy at the National Experimental University Simon Rodriguez in Caracas, Venezuela, in the summer of 1979. He only served there weeks before he lost his battle with cancer. All in andragogy—facilitators and participants alike—have enormously benefitted from his legacy. To Coolie Verner we dedicate this work.

Psychological Factors in Adult Learning and Instruction and *Physiological Factors in Adult Learning and Instruction* were developed as two of a series of ten Research to Practice Monographs under the direction of Drs. Wayne S. Schroeder and Charles Divita, Jr., in an attempt to distil the essence of the research literature into practical guides for learning facilitators. The series was made possible by funds from the United States Office of Education and the facilities of the Department of Adult Education at Florida State University. Verner's two contributions have been reproduced in their original form because we believe them to be as relevant, practical, and timely in 1982 as they were in 1971. May they benefit your thinking, your planning, and your actions as they have ours.

Felix Adam and George F. Aker
Editors

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by Coolie Verner and Catherine V. Davison

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I. LEARNING AND INSTRUCTION AS PROCESSES

Both learning and instruction are extremely complex subjects and both are crucial to adult education. Learning has been studied intensively for a number of years but most of the research has concentrated on learning in animals or in children; consequently, there is little to guide us in applying the results to adults. That adults learn differently from children is not questioned by anyone who has taught both. In this work we have looked at what is known about learning that is particularly relevant to adult education and have attempted to interpret and apply it to adult learning situations. Because there are so many divergent ideas and opinions about every facet of learning, not all psychologists will agree with some of what is reported here, nor with what has been omitted. But the purpose and function of this volume precludes a complex discussion of learning in all of its ramifications sufficient to satisfy everyone.

Instruction is even less well researched than is learning. In this respect, adult education has been remiss in not looking after its own affairs adequately. What is reported about adult instruction is also incomplete and will hardly satisfy everyone, but is culled from research and experience. In the case of both learning and instruction, there is far more substantive knowledge available than finds its way into the minds and hearts of adult instructors so as to alter their behaviors in managing learning.

THE NATURE OF LEARNING

Almost all human behavior is learned. Although little is known about what happens in the brain during learning, quite a lot is known about the conditions under which learning takes place. By understanding these conditions, it becomes easier to plan and manage instruction so that it can enhance learning, but in order to do so, it is necessary to examine the nature and characteristics of the learning process and of instruction designed to achieve learning.

Learning is a complex activity, including not only the acquisition of knowledge and skills, but also of attitudes and values. Although it is difficult to describe or define, it is generally agreed that *learning is a more or less permanent change in behavior that occurs as a result of activity or experience.*

Not all changes in behavior result from learning. Some behavioral changes occur as a result of physical growth and some result from

fatigue, illness, boredom, or alcohol and drug stimulation. Furthermore, not all learning that produces a change in behavior is necessarily good or desirable. An adult can learn to misspell a word, to smoke, or to commit a crime just as readily as he can learn to play a musical instrument or write a novel. Thus, behavioral changes which occur as a result of activity or experience are a product of learning, regardless of whether the change is desirable or undesirable, good or bad.

The act of learning is a *process* rather than a *product*. In other words, learning is the process through which an individual acquires the facts, attitudes or skills that produce changes in behavior. While learning itself cannot actually be observed because it occurs in the mind, it is possible to observe the conditions under which it takes place. One may see what precedes the learner's performance, the performance itself, and the consequences of that performance. Therefore, it is possible for an instructor to detect relations between these conditions and the changes in behavior that occur during learning.

The process of learning is accomplished by the learner's behaving in certain ways. We acquire new facts by reading, studying, looking, and listening. We learn to solve problems by using facts we have learned in thinking about ways to solve the problem. We develop new manual skills by doing the manipulative activity required to perform the skill. Thus, we learn through a variety of behaviors including reading, writing, listening, seeing, talking, thinking, and doing. In addition, we must also learn how to use these activities to learn.

There are several different ideas about how a person learns (Ausubel, 1968; Garry & Kingsley, 1970). Some believe that learning occurs as a result of changes in cognition or knowing, that the learner's perception is crucial, and that learning consists of discovering what leads to what; that the whole is greater than the sum of its parts; and that insight into the relationships among the parts is essential for learning to occur. Thus, instructors who do not think that drill is important in acquiring arithmetic fundamentals are following the *cognitive theories* of learning by giving preference to understanding and thinking.

On the other hand, others emphasize the effects of the environment on learning, the development of the whole from the parts, the importance of previous learning upon present behavior, and particularly, the association of a response with a stimulus. Instructors who favor the use of flash cards in teaching reading are following these *association* theories of learning by giving preference to the association of a stimulus with a correct response. This is the basic idea behind programmed instruction and computer-assisted learning.

The key difference between these two views of learning centers on whether learning is a change in perceptual organization or a change in

stimulus-response connections, and whether reinforcement is necessary for the occurrence of learning. In designing instruction, both types of theories can be considered since no single theory has proved adequate to account for all forms of learning.

THE NATURE OF INSTRUCTION

Instruction, like learning, is a process and not an end in itself. It is a continuing process that aims to facilitate learning by establishing the appropriate external conditions for learning and by managing the learning situation. In performing these two central tasks, an instructor selects and arranges the materials to be learned in light of the needs and desires of the learner; he determines the learning sequence, selects the appropriate learning behavior, and assesses the learning outcomes.

Since an instructor is in charge of the learning process in an instructional setting, it is necessary that he understands how learning occurs and his role in facilitating the acquisition of new learning.

II. THE STAGES AND CONDITIONS OF LEARNING AND INSTRUCTION

An adult may learn many things from the activities and experiences of everyday living within the *natural societal setting* (Verner & Booth, 1964). The amount of learning that occurs in such a setting is difficult to assess. Learning which takes place in the natural societal setting is usually unsystematic and often incomplete. Furthermore, few adults will take full advantage of the potentialities for learning that occur in everyday living. Watching television, reading, talking with others, or working all provide opportunities for learning. Some adults who need or want to learn specific things will set out on their own to acquire the knowledge or skill they seek. Often as not, however, they find this procedure difficult and disappointing.

Through systematically organizing and directing experiences in an instructional setting, the instructor attempts to make learning more efficient and the learner's changes in performance easier to measure. What factors, then, enter into the learning situation and affect its outcome? It would appear that two sets of conditions are interacting simultaneously as learning occurs. On the one hand, there must exist internal conditions which influence the probability that learning will occur. In other words, the learner must be ready to learn. Interacting with these internal conditions are the external conditions established by the instructional process.

INTERNAL CONDITIONS PREREQUISITE TO LEARNING

In order for learning to occur successfully, the learner must be *motivated to learn*; establish an *attentional set*; be in a state of *developmental readiness* to learn (Gagne, 1970); and the *learning environment* must be conducive to learning in ways acceptable to the learner.

Motivation

Learning is unlikely to occur unless the adult is motivated to learn. While motivation is extremely complex and imperfectly understood, it is best seen within the framework of an adult's needs, goals, habits, values, and self-concept. Thus, an adult's willingness to engage in learning depends upon such factors as his perception of the value of learning, his acceptance of what and how to learn, his need for self-esteem or social affiliation with others, and his expectations from life.

There are many different notions about motivation and its influence upon learning. From all of them, it seems clear that motivation arising

from within the individual is far more important than that which is external to him. This *internal motivation* springs from an adult's need and desire to achieve or succeed and it is derived initially from curiosity and related dispositions to explore, manipulate, and cope with the environment. It is activated by successful experience in the past and by the anticipation of future satisfaction. Among disadvantaged adults there is often little in the environment and past experiences to stimulate curiosity or the expectation of success; consequently, positive attitudes toward learning may not have been developed. Within the instructional setting, intrinsic motivation is both initiated and reinforced by the successful mastery of learning tasks and the gradual development of competence. Failure, on the other hand, is likely to lead to the withdrawal of an adult from the learning situation.

Extrinsic motivating factors such as the use of stars on a chart to indicate progress, or the creation of competitive situations are to be avoided since they may cause an adult to fear failure and they may also lead to withdrawal from the learning situation.

In planning instruction, the learning tasks must be scaled so that success in learning is assured within a reasonable time in order to reinforce internal motivation.

Attentional Sets

Attentional sets enable the adult to concentrate upon crucial elements in a learning task rather than being distracted by irrelevant features or events within a learning situation. As adults grow older, they appear to develop a less intense attentional set and are less able to maintain it over long periods of time. In part, this is the result of physiological changes in sensory perception with aging, but it is also a product of experience in everyday life. The natural societal setting provides more stimuli than an adult can handle and some must be ignored. As a result, adults experience a progressive loss of stimulation to which they are set to respond. In a sense, this loss is a defense against the overpowering nature of modern life, and while it does provide protection, it also creates problems when an adult needs or wants to learn. In the learning situation, an instructor may need to use novel or intense stimuli to arouse and focus attention upon the learning task, and he may need to do so frequently if the attention of the learner is to be maintained. Disadvantaged adults who have had little experience with systematic learning may have difficulty in identifying the crucial elements in the learning task and in maintaining the necessary attentional set. This makes it necessary for an instructor to identify for the learner the essential elements in the learning task and to remind him of these frequently.

Readiness

Readiness is a developmental state that results from physiological growth and decline, from psychological conditioning, and from experience in living and learning. Learning cannot occur unless there is a sufficient degree of maturation of the sense organs, the central nervous system, the muscular system, and other physiological equipment. Similarly, learning is not likely to take place unless the individual is properly motivated and is relatively free from such psychological barriers as emotional instability. Finally, learning will be hindered when an adult lacks the previously learned abilities that are prerequisite to the new learning.

These three factors interact to determine an individual's readiness for learning. An adult may be sufficiently developed physically to acquire a specific skill but lack the motivation necessary to achieve an adequate level of proficiency in performing the skill; or he may be both physically mature and sufficiently motivated, but lack the prerequisite capabilities that are necessary to master the skill he seeks to learn. On the other hand, with adequate motivation and prerequisite learning, an older adult may have lost the physical capabilities required by the new learning he desires.

The preponderance of research indicates that adults can learn as well in later as in earlier years, but factors other than mental ability may interfere with the successful achievement of learning. Lorge (1955) introduced the concepts of *power* and *speed* in assessing adult learning. Power represents the mental ability or capacity to learn and this is not affected materially by age until quite late in life for some adults. Speed, on the other hand, which is the time required to master a learning task, is affected by age due to the nature of the physiological changes that are a corollary of aging. Lorge concluded that any adult could learn anything he wanted to learn at any age as well as he could at the peak of his development if given enough time to do so.

For our purposes, it is safe to assume that adults can learn and that we must search elsewhere for the factors that act to impede learning. At this point the most crucial element to consider is the matter of time, and the implication of this factor for instruction is that we must increase the amount of time allotted to the achievement of a learning task beyond that which is needed by youth to accomplish the same learning.

There is also sufficient evidence to suggest that growing up in poverty with inadequate nutrition will impose some limitations upon learning ability (Anderson & Niemi, 1969). Thus, the conditions of poverty may not only affect the physiological development but also the intellectual capabilities of an individual. While this effect is not so pronounced as to suggest that a disadvantaged adult cannot learn, it

does impose some limitations, as yet not fully determined, upon what and how much can be learned and the time required to do so. When this physical disability is added to the scarcity of cultural stimulation, an adult from such a setting may face almost insurmountable barriers to effective participation in a learning situation designed originally for individuals who have not suffered equal deprivation.

Readiness for learning is also a matter of willingness to accept new learning. It is not at all unusual to encounter resistance to new learning among adults. This stems generally from psychic and emotional factors such as fear, insecurity, or attitudes and values. Some adults are fearful of new learning lest they fail to achieve or lest it alter their self-concept. Others may find the new material in conflict with their existing attitude and value systems and are incapable of, or unwilling, to modify those systems in light of the new learning. These factors may prevent an adult from engaging in learning or they may interfere with the accomplishment of a learning task.

As a matter of protection, an adult will erect a number of different psychic barriers to prevent the new learning from effecting any change in behavior. When an adult encounters threatening material, he may exercise selective attention to avoid that material or he may accept the new learning but *distort* it in such a way that it is acceptable to him. If an adult perceives the threatening material as inescapable but wholly undesirable, he may acquire the material but not integrate it into his existing cognitive structure. Thus his behavior is not altered materially by it.

Deep-seated resistance can hardly be overcome. An instructor can try to alleviate the fear of new learning and help the adult build a new basis for security in which the new learning is integrated. Where resistance arises from conflicts in values, there is little effective action open to an instructor.

In too many instances, adult educators fail to take into account the degree of developmental readiness that is required for a given learning task; hence, adults often are put into learning situations in which failure is inevitable. A more judicious attention to readiness for learning could insure that an adult is directed into learning activities better suited to him, rather than ones which are likely to result in failure. Thus, older adults suffering from physical disability should not be encouraged to tackle learning tasks that cannot be accomplished successfully because of such disability.

Learning Environment

Although an adult may possess all of the internal preconditions for learning, he may still fail because of conditions in the immediate learning situation over which he has no control. Adults are influenced by the environment in which they attempt to learn; this environment consists of the physical setting as well as the emotional atmosphere. If either are incompatible with the adult learner or the learning task, the probabilities of successful achievement will be diminished.

The physical setting must be comfortable with respect to furniture, equipment, and temperature, as well as free from external distractions that will interfere with the attentional set of the learner. The emotional atmosphere must be supportive of the adult's attempt to learn. In this connection, the attitude and behaviors of the instructor are crucial; the adult must be treated as an equal and as a person in his own right, without any hint of criticism or depreciation of his attempts to learn.

STAGES OF THE LEARNING SEQUENCE

Although learning itself cannot actually be observed, it is possible to observe what happens before, during, and after learning. This is a *learning event* which consists of several elements that are precisely identified (Gagne, 1970).

In the first place, there is a *stimulus* which affects the learner's senses and initiates a chain of nervous impulses that are organized by the brain. The action that results from this stimulus and the associated nervous activity is called a *response*. When these responses are classified in terms of their effect upon the learner, they are identified as *performances*. Hence, a learning event takes place when the stimulus situation affects the learner so that his performance changes from the time *before* being in that situation to the time *after* being in it. It is this *change in performance* that leads to the conclusion that *learning* has occurred or, in other words, that a new *capability* has been produced in the learner. Learning a new word is a single learning event.

A *learning task* is a series of learning events that are systematically arranged to produce a new and complex capability. Learning to write a simple sentence is a learning task made up of several learning events.

Despite the limitations imposed by not being able to directly observe learning, it has been possible to make some deductions about what probably occurs when an individual learns. This probable sequence of events in learning and remembering is illustrated in Figure 1 and consists of elements both internal and external to the learner (Gagne, 1970; Welford, 1968).

Stimuli

The first step in the learning sequence is the presentation of a stimulus to the learner. This stimulus is inherent in the material to be learned and it directs the learner's attention to the specific learning task. Such stimuli may be cognitive, motor, or affective in nature; they can be simple or complex; and they can be threatening or not. The stimuli are usually selected by an instructor in terms of the goals and objectives of the learner.

Each different objective will have its own specific stimulus or stimulus situation. In learning to read, write or spell, the relevant stimuli are the words to be read, written or spelled. In arithmetic, the stimuli are the numerals used in the arithmetic concept being learned. In the development of a motor skill such as typing, manipulative behavior necessary to perform a typing task as well as the typewriter itself are the relevant stimuli. Similarly, in obtaining verbal information, the stimuli are the facts or information to be learned. In order to initiate the learning process, the stimuli must be *observable* to the learner.

Attention

Since all learning begins with a stimulus, it is particularly important that it be perceived by the learner. In order for the stimulus to start the learning process, the initial response of the learner must be one of attention. Thus, an instructor must present the stimulus in such a way as to gain and hold the attention of the learner.

Different kinds of learning tasks will have different kinds of stimuli. Therefore, the ways in which an instructor gains and focuses attention will vary with the stimulus. A simple expression such as "Watch this" or "Pay attention" may be all that is required in some cases. Pointing or similar gestures can attract attention. On visual devices such as charts and diagrams, the use of sharply contrasting colors, different sizes of print, arrows indicating direction, or similar devices should successfully direct the learner's attention to the relevant stimuli in the material to be learned. It is usually desirable to vary the nature of the attention-getting stimuli since frequency of use may lessen their effectiveness in controlling attention.

Perception

Once the learner is directing his attention to the stimulus, he then begins to perceive and comprehend, to discriminate and differentiate the constituent elements of the material which he realizes are important, or which he has been instructed to observe. It is at this point that he relates the new material to what he already knows and to his present expectations from learning. If he perceives this relationship as being a close

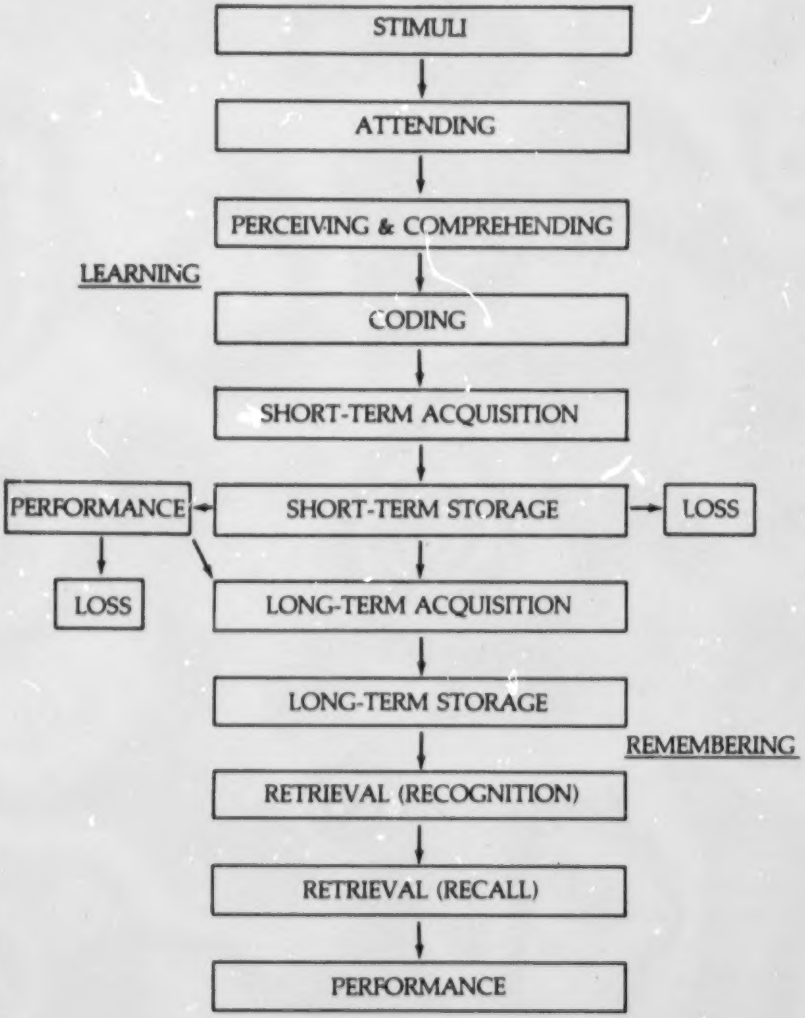

FIGURE 1. The events in learning and remembering

one, he probably will attach greater importance to the new material.

Adequate perception of the learning task can be facilitated through the use of directions provided by the instructor. This may be done through verbal communications or visually by demonstration. Through such directions, the learner is made aware of what he must do in order to complete a learning task, as well as how the task is to be accomplished. Directions also should provide the learner with an awareness of the nature of a successfully completed learning task so that he can judge for himself the progress that he is making in learning.

Different kinds of learning tasks may require different kinds of directions. For example, tasks involving verbal information may involve only simple verbal directions such as "Read this section of material." Intellectual skills may require verbal directions such as "Describe this object" or "Classify these items." Manual skills may require visual directions accompanied by verbal attention-getting communications such as "Watch my hands as I assemble this object."

Another important function of directions is that of stimulating the recall of previously learned material that is a prerequisite of a new learning task. In some cases the instructor may choose to have the learner simply recognize what he has learned previously. For example, an instructor can stimulate recognition with the statement: "You will remember when the salutation, 'Gentlemen' is used in a business letter." On the other hand, it may be desirable to have the learner restate previously learned material as would be the case with the question, "What are the seven major parts of a business letter?", which should stimulate the recall of previously learned material.

In some cases, an individual may not have learned the prerequisite capabilities for a given task, and it will be necessary to acquire these before beginning to achieve the new learning. When the necessary groundwork has been established, the instructor then can proceed to the new task with some assurance that the learner possesses the capabilities necessary to tackle the task.

In addition, the directions that are given to the learner must be clear-cut and precise. It is also important that they be clearly differentiated from the learning stimuli, particularly when both the directions and the learning stimuli are verbal.

Coding

After attention has been directed to the stimulus so that the learner perceives the material and selects the elements which are important to him, the learner then proceeds to code the information in a way that is functional to his unique memory storage system. This coding usually

consists of transforming the stimulus into manageable "bits" which he can handle efficiently. Although too little is known about coding to enable an instructor to influence how the learner accomplishes it, the way in which new material is presented in manageable units will facilitate this activity. Inexperienced learners will require that the new material to be learned be presented in smaller units.

Acquisition

The acquisition stage follows immediately upon the coding stage, but what actually occurs in the brain at this point is not clear. What probably happens is that the learner integrates the new material into his cognitive structure and in doing so, his behavior is changed. In other words, the learner internalizes the new material so that his learned capability with respect to the specific learning task has been altered.

Storage

When acquisition has been completed, the learner must then hold the new capability in storage in his memory system. This particular aspect of the learning sequence will be discussed more fully later. From this point on, the learned material is either retained and put to use or forgotten.

THE INSTRUCTOR'S ROLE IN EVOKING LEARNER PERFORMANCE

As the learner works through the stages in the learning sequence, the instructor can help by providing guidance and knowledge of results.

Providing Guidance

It is difficult to know when an instructor should step in and give guidance to the learner or when to let him proceed on his own. Certainly an instructor should intervene when it is obvious that an error of some magnitude is occurring. But error is unavoidable, of course, and may even be helpful so long as it contributes to the development of knowledge about the appropriate action.

As a general rule, guidance in small amounts early in the learning activity, particularly with respect to motor tasks, is beneficial but the effectiveness decreases the further along it occurs in the process. This suggests that in acquiring a skill, the learner must perform with limited amounts of help. In some cases, as with cognitive material, it appears that the *active participation* of the learner that occurs with self-discovery is more conducive to learning than is too close supervision and direction by the instructor.

Guidance is effective in helping the learner establish appropriate learning sets. Nevertheless, too much guidance or guidance that is given too late may have a detrimental effect. It should be used as necessary when it is directed toward helping the learner to break old fixated responses, to correct continuing errors, or to assist the learner to unlearn material that is being replaced by the new learning.

Providing Knowledge of Results

Perhaps a more effective means of improving performance is to provide the learner with knowledge of the results of his learning or *feedback*. Feedback may be internal or external. *External feedback* includes the information about the effectiveness of his learning that the instructor provides to the learner, as well as the information which he may acquire through self-observation. *Internal feedback* is obtained from internal receptor organs. In learning a skill, for example, the correct performance of a movement that is well executed will "feel right." This kind of feedback may be more obvious in skill learning such as driving a car or operating a typewriter, but it will also occur with other kinds of learning tasks such as language development.

The relative emphasis placed on feedback varies with the stage of the learning, the confidence of the learner, and the nature of the task. For an adult experienced in learning, constant feedback is less important than with the inexperienced. In providing feedback, even to experienced learners, it is wise to avoid adverse criticism, particularly in the early stages. Emphasis upon correct responses leads to greater learning than does emphasis on errors.

THE PROGRESSION OF LEARNING

The rate at which learning occurs is influenced by many factors, including the ability of the learner, his interest and previous experience with learning, and the nature and difficulty of the material. Because of these and other related factors, different people learn at different rates. Therefore, it cannot be expected that all adults will make the same progress in learning new material.

In the initial stages of learning, the progress of the learner usually is slow and then accelerates as he increases his capability for dealing with the new material. After a period of time, a point often is reached in which the rate of learning slackens and no improvement is seen in the learner's performance. Thus, the curve of learning has the shape of a lazy "S."

The slow beginning may be due to a number of factors. The adult may have difficulty in remembering previously learned material that is

prerequisite to the new task; he may be unaccustomed to the act of learning; he may be poorly motivated or fearful of failure; or the instructional techniques may be inappropriate for the material or the learner. As these initial barriers are overcome and the learner's familiarity with learning and the new material build his confidence, the rate of progress should accelerate. Then, in time this increase in performance might slacken when the task has been accomplished, the learner reaches the limits of his ability, or when other factors such as boredom or a decrease in motivation intervene.

When a *plateau* is reached in the rate of learning and no further progress is made, the instructor must take some action to spur on the learner. This may involve a change in the nature of the learning task, a rest period, or some other action to trigger a continuation of learning.

III. REMEMBERING AND FORGETTING

Through the process of learning, an adult acquires learned material that may be useful or desirable to him. In order for this material to be available when it is required, it must be retained; yet most adults forget much of what they have learned. Learned material is stored in the memory and it is called for use through the process of *remembering*. The *retention* of learned material is influenced by the nature of the material and by the ways in which the initial learning occurred; consequently, an instructor can influence retention by the ways in which he manages the original learning situation.

MEMORY

The memory is the "storage warehouse" where learned material is retained until the learner needs or wants it (Hunter, 1962). This warehouse apparently operates on two levels. On the one hand, there appears to be a *short-term memory* mechanism that is a temporary holding bin of limited capacity. Over a period of time it can handle a vast quantity of material, but at any one moment in time, its capacity is limited.

Once the material has been placed in the short-term memory, it is then subject to one of several different operations. If the learned material is needed only for a short time, or to be used only once, it need be retained only from the time it is perceived until the time it is used, after which it can be discarded. This is what might occur when an adult seeks a number from a telephone book and retains it only until he has completed dialing.

If the material deposited in the short-term memory is deemed of sufficient importance to be retained longer than a few moments, it may be transferred to the *long-term memory* for more or less permanent storage. In such a case, the material is again coded or re-coded for permanent storage. Generally, when the learned material is retained for more than a few minutes, the transfer to the long-term memory is considered to have begun.

Some material that is placed in the short-term memory is neither discarded after immediate use nor transferred to permanent storage. Such material is simply lost as new learning enters the short-term memory.

The short-term memory span is affected by conditions that are both internal and external to the learner (Hunter). Age and intellectual capability as well as the physiological condition of the learner will affect the short-term memory span. On the other hand, noise and similar

distractions at the time of learning will decrease the holding power of the short-term memory.

The long-term memory may be affected by the same internal factors that influence the short-term memory span. In addition, to retain learned material, it would appear that a *memory trace* must be established that is durable and capable of withstanding interference effects from other learned material. In other words, such a trace must be capable of enduring until the material is required for use.

REMEMBERING

Remembering is the process through which the effects of past learning are manifest in the present. There are two principal ways in which remembering occurs.

When an adult encounters an object, person or information that is known to him, such awareness occurs through the process of *recognition*. The ability to recognize things that are known through previous learning constitutes the largest part of an adult's memory system.

Remembering by *recall* occurs when an individual reproduces previously learned material unaided. The most familiar example of the use of recall is in talking or writing, which requires that an individual remember the words he needs in order to communicate his thoughts.

Recall and recognition are the two most important aspects of remembering but there are other processes that occur. *Recollection* is the process of remembering a complex of events that occurred at the time of learning while *reconstruction* is the reproduction, not of the learned material itself, but of the order in which it was originally presented.

The ability to remember through recognition is greater than that by recall. This is illustrated by an adult's use of words. In reading, an individual can recognize and know many more words than he can recall in speaking or writing. Recognition memory is tested by questions that provide clues such as true-false, or matching questions. Recall memory is tested by questions that do not provide clues such as essays or questions with blanks requiring the individual to supply the missing words or ideas.

INSTRUCTIONAL FACTORS AFFECTING RETENTION

The retention of learned material is influenced by the nature of the material, the use to which it is put, and the way in which it is learned. Since the ultimate objective of learning is to have available for use the

knowledge, skills, or attitudes that have been learned, the matter of retention is of the utmost importance. In order to enhance retention it is essential that a number of conditions be present in the instructional situation at the time the initial learning occurs.

Nature and Use of the Material

Some material is learned more quickly and retained longer than other material. Manual skills that are learned to a high state of proficiency appear to be retained indefinitely even though the degree of proficiency in the performance of the skill may decline through disuse. Any kind of manipulative learning is retained longer than verbal information under any circumstances. Why this should be so is not known for certain.

Material that is *meaningful* to the learner is retained longer than that which is not. Thus, understanding the material, seeing its relationship to previous learning or to the individual's goals and objectives, and his awareness of the practical utility of the material to be learned will increase retention. Thus, new words that will enlarge an adult's working vocabulary will be remembered longer than will nonsense syllables or obscure terms. Meaningfulness also may be a matter of previous familiarity and can be established by the instructor through verbal directions or visual illustrations, or by relating the new material to what the learner already knows. Finally, meaningfulness may lie wholly within the material itself, as in the case of patterning. The number sequence of 2-7-12-22-27-32 is more meaningful than 9-3-15-16-21-18-7 because the former list has a pattern consisting of intervals of five, while the latter is a random sequence.

The more often an adult uses what he has learned, the longer he will remember it. This is readily verified by experience. A poem, once learned, that is remembered and frequently recited either mentally or aloud will be remembered longer and more perfectly than one that is recalled only rarely. Similarly, the occupation of an adult will affect retention, since the material that is learned to perform in an occupation is used frequently and is not forgotten quickly. Accountants or others dealing with figures are less apt to forget the mathematical processes than are those who do not use figures consistently. At the same time, they will tend to forget other kinds of learning that they don't use. Thus, clerical workers will maintain linguistic skills but lose arithmetical facility through disuse.

The frequent use of learned material increases retention because each time something is used it is relearned. Unused material that is forgotten will have to be relearned if it is needed at a later date. The

more perfectly this forgotten material was learned in the first place the easier it will be to relearn it. But, the longer the lapse of time since the initial learning, the more time will be required for the relearning.

Since the use of learned material influences retention, it is desirable to plan instruction so that new material is used immediately and frequently. As a matter of fact, there is not much point in expecting or requiring an adult to learn anything that will not be immediately useful either as a prerequisite to some further learning or in everyday life. The best time to learn anything is immediately before it is needed so that the subsequent use will enhance retention.

New material should be learned in the way in which it is to be used later. Things that are to be used in isolation should be learned in isolation, while material that will be used in series should be learned in series. Thus, poetry should be learned as a unit since that is the way it will be used, but the multiplication of two numbers should be learned in isolation rather than in series such as memorizing the multiplication tables. Furthermore, material that will be needed in the future only by recognition should be learned that way while material that will be required by recall should be learned by recall. An adult who seeks to learn only to read a foreign language, which is a matter of recognition, need not learn to write or speak that language.

The performance of tasks in which there is little interest results in relatively little learning since only those materials and activities that are perceived as relevant by the learner can be meaningfully incorporated into memory on a long-term basis. The traditional content introduced in educational programs often is not perceived as relevant by the disadvantaged, so they may feel little need to know and understand what is being taught, and quite naturally, expend little effort to learn. As a result, they may manifest an insufficiently meaningful learning set and fail to develop precise meanings, to reconcile new ideas with existing concepts, and to formulate new propositions in their own terms. Moreover, because the disadvantaged adult often is unwilling to engage in learning by devoting time to practice and review, material might never be sufficiently consolidated to form the necessary foundation for future and sequential learning.

Overcoming Interference Effects

As noted earlier, the retention of learned material is affected by the sequential order in which the learning occurs. On the one hand, there is the interference which results when some previous learning inhibits the acquisition and recall of new material being learned; this is called *proactive inhibition*. On the other hand, *retroactive inhibition* comes

into play when some new learning occurs between the initial learning and the recall or use of some older learned material. The interference exerted by both proactive and retroactive inhibition can be controlled by the way in which the learning tasks are organized at the time of learning.

In the case of proactive inhibition, a learning task should be completed and then followed by a period of rest before the new task is tackled. This will reduce the interference created in retaining the second task. Similarly, retroactive inhibition can be avoided by insuring that a given learning task is completed without a new task coming between the initial learning and application of the first task. The greater the similarity between the two learning tasks, the greater the interference of both proactive and retroactive inhibition. Because of this, it is wise to plan the sequence of learning tasks so that they are as dissimilar as possible. Thus, one can follow a learning task in mathematics by one in history without introducing interference, but to follow one task in mathematics by another similar task in the same area will increase the interference with retention.

Providing for the Transfer of Learning

Learning should be applicable in a wider context than the specific situation in which it is achieved; there must be a *transfer of learning* from one situation or event to another for which it is appropriate. The transfer of learning may occur automatically, but it is usually necessary for the instructor to insure transfer by introducing certain events into the learning situation that will encourage it.

The transfer of learning may be either lateral or vertical. *Lateral transfer* involves the application of capabilities learned in one situation to a different situation. A student in adult basic education may have learned about dividing a pie among her children, and this learning can be transferred to the solution of problems in arithmetic involving fractions. *Vertical transfer* occurs when a particular learned capability is used in learning a higher order of capability. This is the case when knowledge of basic arithmetical functions is used to master statistics.

In order to facilitate lateral transfer, the instructor can plan learning so that a given bit of learned material is applied in as many different situations as possible. Vertical transfer is accomplished when the learner is reminded that he knows the learning prerequisite to a new learning task, as discussed earlier. Transfer relies heavily upon meaningfulness, the formulation of generalizations, and a thorough understanding of the original concepts or principles involved in a learning task.

Other Ways of Increasing Retention

As noted earlier, the immediate use of learned material will enhance retention. In the learning situation, immediate use can be achieved through *practice* which is particularly applicable to such learning tasks as motor skills or language.

The first aspect of practice to consider is the question of massed or spaced practice. In general, spaced practice is considered to be more effective than massed practice. Spaced or distributed practice is particularly important at the early stages of learning where error is more apt to occur. If massed practice is used at such a time, there is a very real danger of an error in performance being learned so well that it is difficult to unlearn and correct. After the initial learning has been completed satisfactorily, massed practice may be used by some learners to develop proficiency in performance. For the most part, distributed practice is useful in maintaining a high level of performance.

The next aspect of practice to consider is that of the length of the practice period, whether spaced or massed. The answer to this question depends upon the nature of the learning task and the condition of the learner. The practice period should be long enough for the learner to finish at least three complete performances of the task, but not so long as to introduce fatigue. With tasks that are relatively simple, or with learners with more experience, the practice period can be longer, but with complex tasks or inexperienced learners such as disadvantaged adults, shorter periods are preferable. Every practice period must be followed by a period of rest, although this should not be so long that the learner forgets or loses what he accomplished in the practice period. On the other hand, it must be long enough to reduce fatigue or to permit incorrect responses to be eliminated.

Retention is also facilitated by the activities associated with the development of the transfer of learning, particularly when the learning task is of such a nature that prolonged practice periods are not appropriate. Instructors can facilitate the retention and transfer of learning by such activities as the following:

(1) Encouraging the learner to search for relationships between what he is currently learning and his past learning. Transfer possibilities increase as the learner actively searches for points of similarity and difference in two or more situations. Retention is increased as the learner reorganizes facts, concepts, and principles into a meaningful structure.

(2) Providing reviews in which the learner encounters previously learned material within new activities. Overlearning and the structuring of old learning in new situations aid both retention and transfer. Present research evidence indicates that the degree of original learning is the crucial variable in retention.

(3) Providing well-distributed practice in problem solving. Problem solving is itself an exercise in transfer as the learner strives to relate what he knows to a problem situation, and problem-solving skills once attained are well retained.

(4) Relating materials learned in instruction to the abilities, needs, and interests of the learner. Several studies demonstrate the relationship between intelligence level and the amounts of transfer and retention. The learner tends to perceive and remember more accurately material in which he is interested.

(5) Stressing generalizations, but making certain that the learner understands the meaning and factual basis for each generalization taught.

(6) Scheduling frequent tests or in other ways creating a "set" to remember.

(7) Inducing low stress by arranging for success or anticipation of success experiences in learning. Some evidence indicates that individuals tend to persist in low-stress situations and become ego-defensive in failure situations (Loree, 1970).

IV. DESIGNING AND MANAGING INSTRUCTION

An instructor has an indispensable role in the successful achievement of learning, but this role is so complex and crucial that it is somewhat terrifying to even consider the number and kinds of strategic decisions that must be made. Such decisions cannot be made solely as learning and instruction are progressing. Therefore, the learning experience must be carefuly planned in advance. The planning of a learning experience involves a number of interrelated steps, including identifying the instructional objectives, selecting and arranging learning tasks, determining the most appropriate learning behaviors, and making provision for the measurement of achievement.

IDENTIFYING OBJECTIVES

Objectives identify the specific behavioral changes that are expected to result from the act of learning. They serve as a guide for establishing the conditions of learning and for assessing the results of learning. Objectives can be conceived of on two levels:

Program objectives are more properly *goals* for they describe the general aims of both participants and those conducting the program. In educational programs for disadvantaged adults, the goals may be to make them employable, to become better citizens, or to obtain greater personal fulfillment. Within the context of any single program objective or goal will be an almost bewildering variety of possible activities that can lead to the achievement of the goal. In the matter of employability, for example, might fall such topics as learning a vocational skill, making application for a job, obtaining information about job opportunities, or any other areas of knowledge that may be required in order for a disadvantaged adult to become employed. From such an array of potential topics an instructor must select and arrange those most essential and appropriate for the particular goal. From these topics, he can then outline the program as a developmental sequence of learning activities.

Instructional objectives identify the particular and specialized terminal behaviors which the learner can be expected to achieve as a result of learning. Each topic that has been selected for a program will consist of a number of instructional objectives. Since instructional objectives identify terminal behaviors, they reflect the performance capabilities to be learned and are, therefore, overt behaviors that are observable. Concepts such as knowledge, understanding, appreciation, or enjoyment

are not observable behaviors and can only be inferred from performance, but one can observe a learner's ability to classify, describe, demonstrate, make, read, or write.

Mager (Kibler, Barker, & Miles, 1970) lists three questions that must be answered positively for any adequately defined instructional objective:

(1) Does the statement describe what the learner will be doing when he is demonstrating that he has reached the objective?
(2) Does the statement describe the important conditions (givens and/or restrictions) under which the learner will be expected to demonstrate his competence?
(3) Does the statement indicate how the learner will be evaluated, i.e., does it describe the lowest level of acceptable performance?

Such preparation of instructional objectives is completely functional for the subsequent design of learning since it identifies the appropriate learning tasks necessary to achieve the objective and it limits the learning situation to those tasks that are truly relevant.

The behavioral changes that are accomplished primarily through the process of learning are numerous and varied. Professor Robert M. Gagne (1970) has identified and catalogued five basic types of learning outcomes which he calls the *objectives* of learning. These are as follows:

Motor Skills—This category of learned capability could appear in many occupational areas. In addition, it would be found necessary in certain basic skills common to all areas, such as those of handwriting and language pronunciation.

To the person watching an expert stenographer perform, typing appears to be a smooth, rapid, effortless rhythm, but to the beginning typist, it is an awkward, disconnected, complex process. Between the two extremes lies a series of developmental phases which occur in learning most motor skills.

The instructor must assist the learner to develop a concept of the skill to be performed, establish an appropriate cognitive set for discriminating the various subroutines which are involved in performance, help the learner to differentiate between appropriate and inappropriate responses, and organize the subroutines into a hierarchy that will produce an adequate level of skill. Beyond this, the learner must be given opportunities to *practice* the skill in order to develop his proficiency in performance. Through practice, the learner's behavior will undergo considerable transformation. In beginning to type, for example, the movements are likely to be awkward, hesitant and jerky, but as practice proceeds, useless movements such as tentatively fingering a key

before pressing it are eliminated and those movements essential to skilled performance such as pressing the keys firmly or throwing the typewriter carriage quickly are made with greater promptness and precision until the performance becomes unified, stable and highly integrated.

Intellectual Skills—An intellectual skill is involved whenever the individual shows he is able to perform a human activity that requires mental processing: distinguishing varieties of objects, forming classifications, applying the rules of language and mathematics, solving practical problems. It is intellectual skills that are learned as the basic skills of reading, listening, writing and using numerical operations are employed. More complex intellectual skills are built upon simpler skills and efficient learning requires the arrangement of both internal and external conditions. Arranging the internal conditions means assuring that the learner has acquired the prerequisite skills and informing him of the expected outcomes of the new learning.

Verbal Information—For most adults, education is equated with the acquisition of information, and undoubtedly, a large amount of time is devoted to this end. For objectives involving the acquisition of information, the length, difficulty, and meaningfulness of the material inevitably must be considered, but what conditions make this learning more efficient? Since past learning constitutes a reservoir of information, experiences, and strategies for structuring new learning, an instructor may facilitate the acquisition of new information by first reviewing familiar material which is related to the new material to be learned. This familiar introductory material is known as a *cognitive organizer*, and its value in the learning and retention of meaningful verbal information has been frequently demonstrated. For example, an individual who first learns that obtaining a job depends upon such factors as personal, educational, and experiential qualifications is in a better position to assimilate information about the qualifications required for a particular job.

Recent evidence suggests that the best preparation for learning new verbal information, on the part of the learner, is the prior acquisition of masses of information highly organized and well differentiated. The most effective presentation of information to be learned will be that given in terms of a meaningful context which can be readily related to previously learned idea structures.

Cognitive Strategies—The ability to apply appropriate cognitive strategies is a form of intellectual skill, but the kind which governs an individual's own behavior in learning, remembering, thinking, and problem solving. Because an individual continuously faces changing

conditions and circumstances, he must be able to vary his responses, to transfer previous learning to new situations, and to acquire a systematic method of modifying his behavior, or learning how to learn.

Little is known about cognitive strategies so that the conditions considered necessary to bring about learning are still being questioned. It appears that the ability to solve problems, to evaluate, to recall previously learned material, or to create is improved by *practice*. This improvement results from acquiring the means to think with, and also from learning the best procedures for using these materials effectively. Thus, learning and thinking are linked in two ways: first, one learns by thinking, and second, one improves his ability to think by learning. In guiding learners in problem solving, an instructor's task is (1) to ask questions requiring thought and to assign problem exercises; (2) to assist learners in clarifying and defining a problem; (3) to stimulate suggestions for solutions and direct the learners to sources of data bearing on the problem; and (4) to foster a critical attitude toward the suggestions so that they will be properly evaluated and tested before finally being accepted as solutions.

Attitudes—The learned capabilities called *attitudes* influence the choices that an individual makes. The process through which attitudes are learned or modified may be described in three ways—as an identification, as a conditioning process, or as a function of the interaction of information acquired with existing feelings, beliefs, and actions.

Frequently, in establishing or changing attitudes, information alone has been found to be ineffective although it might be successful under certain conditions. An instructor seeking to help a disadvantaged adult to develop a positive attitude toward the value of being able to read might do so by encouraging the adult to discuss the many uses of reading. It is probable that an adult will also acquire a positive attitude toward reading by learning to read.

The objectives presented here identify five general capabilities or specific kinds of behaviors that are learned and used by an adult. Although it has been common to think of learned behaviors solely in terms of specific subject matter content such as history, arithmetic, reading or typing, this classification shows that all subject matter areas contain many of the same common capabilities. By looking at learner behaviors in terms of these objectives rather than subject matter objectives, it is easier to understand the learning process and to design instruction that will accomplish learning more efficiently. The same learning conditions are involved in acquiring facts and information regardless of whether they are related to history, arithmetic, science or any other content area. Similarly, the conditions governing the

development of a skill are the same, whether it be operating a typewriter, playing a piano, skiing, or running a milling machine.

ORDERING THE LEARNING TASKS

When the appropriate tasks have been identified, the next step involves the arrangement of the tasks in a sequence that permits the learner to develop his capabilities to the point where he can perform the behavior specified by the objective. The ordering of the tasks may proceed from the known to the unknown or from the simple to the complex, as the nature of the task may dictate. In determining the sequence of the learning tasks, an instructor begins with the terminal behavior specified by the objective and then works down from step to step in terms of the prerequisite capabilities. When the analysis is continued progressively to the point of delineating an entire set of capabilities having an ordered relation to each other and to the objective, one has a *learning hierarchy* (Gagne, 1970). This learning hierarchy specifies the enabling conditions within the learner which are necessary for him to acquire new learning. Through this procedure an instructor can avoid missing essential steps in helping an adult learn. With the learning hierarchy identified, an instructor can then determine the point at which to begin the instructional process by assessing what the learner has already learned in the sequence of tasks.

In ordering the learning tasks it is necessary to determine which tasks can be handled as a unit and which must be divided into smaller subtasks. This is known as the *partitioning* of performance. Partitioning of performance involves the question of the relative superiority of learning a given unit of material as a whole, or doing so by separating it into parts which are later combined into the whole. The answer to this question is unclear because of the number of ways in which learning tasks and learner characteristics may vary, and because of differing perceptions of what is considered a whole and what is considered a part with respect to learning tasks. There is some evidence to suggest that partitioning is not necessary nor even desirable if the material is relatively simple, if it is a complete unit, if it can be completed in the time available, and if it will be ultimately used as a whole. Furthermore, whole learning is more successful with the more experienced learner. On the other hand, the separation of material into sequentially arranged parts appears to be preferable if the material is complex, the time is limited, and the learner less experienced or less capable.

When partitioning material for adults, considering the attitude of the learner is of utmost importance. With the whole method, more time

and effort are required before any results of learning are evident, whereas the part method provides a feeling of successful achievement as each part is mastered. With certain adults, particularly the disadvantaged, the quick and continuous feeling of achievement will strengthen motivation, and this may prove to be more important than other considerations in the successful achievement of learning.

SELECTING INSTRUCTIONAL PROCESSES

When the appropriate learning tasks have been arranged and the related conditions and factors identified, it is then necessary to choose an appropriate instructional technique. In so doing, all of the material discussed previously must be utilized. As noted, learning involves a number of different kinds of behaviors by a learner which assist learning. An instructional technique prescribes and orders these behaviors and concentrates them on the learning task. Different kinds of learning tasks require different learner behaviors; consequently, different tasks need different instructional techniques. No one technique is appropriate for all learning tasks and some techniques are suitable for only certain kinds of tasks. The lecture is an instructional technique that prescribes listening as the learner behavior. This may be appropriate for a task involving verbal information but not for manual skills or cognitive strategies.

Although research into the effectiveness of various techniques with various kinds of learning is limited, there are several generalizations that can be safely made. Learning objectives are accomplished more readily and more effectively when a variety of techniques are employed. Techniques that prescribe active behavior in learning are generally more successful than those that involve passive learner behavior.

It must be remembered that adults may be conditioned by previous experience to a limited range of instructional techniques, so that it also may be necessary to help them learn to use a technique in learning. Furthermore, previous experience with learning will develop attitudes about learning that may influence the effectiveness of a technique, and previous experience also will have established a style of learning in each individual so that certain techniques may be ineffective.

The characteristics of the disadvantaged adult will naturally influence the effectiveness of an instructional technique. Due to his lack of experience with techniques in which the learner bears the major responsibility for learning, such as group discussion, it is unlikely that the disadvantaged adult will be willing to become an active participant in learning tasks. At the same time, his need for activity will cause him to resist those techniques which involve passive learner behavior. Ac-

tivities such as role-playing, projects, or manipulative behavior would probably be more acceptable. Since the disadvantaged adult depends more on nonverbal forms of communication, lectures or recitation techniques might be resisted, but illustrative and manipulative devices should be acceptable.

The learning process itself imposes certain requirements upon instruction that will influence the selection of techniques as illustrated below:

(1) Learning is an active process and adults prefer to participate actively; therefore, those techniques which make provisions for active participation will achieve more learning faster than those that do not.

(2) Group learning is more effective than individual learning; therefore, those techniques based on group participation are more effective than those which handle individuals as isolated units.

(3) Learning that is applied immediately is retained longer and is more subject to immediate use than that which is not; therefore, techniques must be employed that encourage the immediate application of new material in a practical way.

(4) Learning new material is facilitated when it is related to what is already known; therefore, the techniques used should help the adult establish this relationship and integration of material.

(5) The existence of periodic plateaus in the rate of learning necessitates frequent changes in the nature of the learning task to insure continuous progress, therefore, techniques should be changed frequently in any given session.

(6) Learning is facilitated when the learner is aware of his progress; therefore, techniques should be used that provide opportunities for self-appraisal (Verner & Booth, 1964).

ASSESSMENT OF ACHIEVEMENT

Because of the hierarchical nature of most learning, the instructor needs some assurance that the learner has obtained the simpler prerequisite capabilities before proceeding to higher order learning. In managing instruction, therefore, provisions must be made for the continuous evaluation of a learner's progress and for a final appraisal of his performance upon completion of a task.

The instructional and program objectives provide the criteria for assessing progress in learning and without these objectives it is not possible to determine if learning has occurred satisfactorily to the level

desired. Throughout the process of learning some assessments of progress are made. Feedback provides some measure of the learner's performance at different intervals but this is not always sufficient. Evaluation during the process of learning will help an instructor determine the effectiveness of the design for instruction and the appropriateness of the technique used.

The nature of evaluation will, of course, vary with the nature of the learning task. Tasks involving verbal information can be measured by a test, manual skills by performance, or cognitive strategies by solving a problem. No one process of evaluation can be applied to all learning tasks, which is what occurs when we attempt to use a traditional test. An important consideration in designing evaluation instruments is that the procedure used must measure the *identical behaviors* specified in the objectives. If these two criteria are met, and the learners do not perform acceptably on the objectives, an explanation may be sought from among the following reasons:

(1) The unsuccessful learners were prepared inadequately for the unit, which could mean that the objectives were unrealistic or that the learners should not have begun the unit without prior training.

(2) The unsuccessful learners were not motivated properly to master the material.

(3) The instruction was not designed properly or insufficient time was provided for the learners to master the objectives (Kibler, Barker, & Miles, 1970).

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PHYSIOLOGICAL FACTORS IN ADULT LEARNING AND INSTRUCTION

by Coolie Verner and Catherine V. Davison

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I. INTRODUCTION

Every adult needs to learn new things at every stage in life. Some adults can achieve this learning on their own through the process of *self-education*. Some learn something of what they need to learn unintentionally, merely by encountering and resolving the problems of everyday life. Still other adults become involved in instructional programs designed for adults. Whatever approach adults may take to satisfy their learning needs, the success of their efforts will be affected by their ability to learn, their motivation, and their physiological condition.

The physiological condition of the learner exerts a significant influence on learning. This fact is often poorly understood and ignored by both the adult learner and the adult educator. Nearly every adult experiences some kind of physical disability that may be the source of some learning difficulty. This may result from an inherited characteristic, from injury or disease, from inadequate nutrition, or from the natural process of aging.

From whatever source it may arise, the physiological condition of the learner will affect learning and performance in a number of ways that need to be examined. All learning begins with the presentation of a stimulus, and since the eyes and the ears are the principal channels to the mind for most learning stimuli, these two organs require special consideration. Many of the learning difficulties that stem from deficiencies in hearing and vision are affected by conditions in the learning situation itself. Hence, an instructor can often minimize or overcome the barriers to learning resulting from defective vision or hearing.

Even with the provision of compensatory conditions in the learning situation, the learning process and the proficiency of performance will be affected by the physiological condition of the learner in ways that do not result directly from changes in visual or audio acuity. Here again, an instructor can reduce the barriers to learning and performance that may occur.

In healthy, normal adults, there are physiological changes resulting from age that must be taken into account not only for the physical consequences of such changes, but also for the psychological impact of the aging process. This process affects vision and hearing as well as acting directly upon learning and performance. Consequently, some consideration of aging must be given at the outset.

II. THE AGING PROCESS

Because aging is a developmental process that occurs slowly and gradually, adults are often unaware of it until some traumatic experience brings it to the forefront of attention. Furthermore, since society puts a premium on youth, adults often are unwilling to concede that age alters their capabilities or that performance in any area of human activity is affected by the passing years.

Aging begins at the moment there is a cessation of growth and development in the human body. Hearing loss begins to occur at ten years of age, while loss in visual acuity does not begin until about twenty years of age in the normal eye. It is not until the loss of function in the whole system becomes significant that we begin to identify aging as a particular condition. Thus, in any group of adults the loss of function is taking place to some degree and it is not reserved just for those who are very old.

Although physiological changes occur gradually, they have a psychological impact upon an adult that should not be underestimated. Among young adults the changes are generally not noticed because they are subtle and inconspicuous. Older adults have usually become conditioned to the physical limitations imposed upon them by age. The greatest impact of age is felt by adults in the middle years of the thirties and forties for it is at this time that the cumulative effects of aging begin to become obvious. This influences the way in which an adult regards himself. At first, he may reject the idea that his physical capabilities are declining and often overextend himself to prove that it is not happening. Since change is inexorable, however, he must come to accept the limitations imposed upon him by altering his activities and by changing his expectations of self. For some individuals, the sudden realization of age is debilitating; it induces unnecessary anxiety and tension and may become a block to the development of a different, although equally rewarding, life style. Other individuals learn quickly to adapt to physiological changes and to grow old gracefully without depriving themselves of interesting and exciting experiences that may make the middle and later years even more satisfying than youth.

Consciousness of age alters an adult's expectations of himself and his future so that involvement in learning is usually modified. This may be noticeable particularly with respect to motivation and to measures of achievement. The adult's motivation to learn will tend to change from the search for external reward to internal satisfactions. This, in turn, will influence the choices he makes with respect to what he wants to learn, and he usually will tend to turn from activities related to his occupation

toward those he sees as interesting and useful pursuits that are personally rewarding.

Since age influences motivation to learn, the adult can be expected to respond to learning tasks differently than youth. The tasks will need to be perceived by him as immediately meaningful and useful and he probably will be less content to satisfy prerequisites which a younger adult will accept as necessary to achieve his ultimate objective. In addition, the older adult will tend to resist tasks that impose excessive strain on his declining capabilities.

The physiological changes associated with and resulting from age are influenced by the life style of the individual adult. In normal circumstances, an active physical life through work and recreation, along with an adequate diet containing the necessary nutritional requirements, insures that the physiological changes occur naturally and gradually so that the normal life of the adult is not suddenly noticeably restricted. Furthermore, active participation in the ongoing life of the community reduces preoccupation with self, enabling an adult to make reasonable adjustment to the effects of age.

Among disadvantaged adults, the onset of aging occurs earlier in life and physiological decline is more rapid (Anderson & Niemi, 1969). Disadvantaged adults often do not have an adequate diet with the necessary nutritional elements to insure that aging occurs naturally. As a result, they are usually more susceptible to disease, have reduced recuperative powers and have less energy to meet the demands of daily living. The impoverished environment in which they live frequently offers no support to efforts the individual may make to resist the accelerated pace of physiological decline. Consequently, the psychological consequences of physical decline are accentuated. The disadvantaged adult tends to submit to rather than accommodate the aging process. If he believes that he cannot alter his situation, he probably will make no effort to do so.

Age itself is no barrier to learning. The evidence that has accumulated about adult learning indicates that age-related changes in the primary ability to learn are small and not significant in most cases. Studies comparing test scores achieved by the same adults at different ages have concluded almost unanimously that the scores achieved at the later age were superior to those obtained earlier. This suggests that abilities, at least with certain kinds of tasks that were tested (Table I), tend to increase rather than decline with age. What may appear to be changes in learning are attributed more readily to the physiological and psychological conditions of the learner resulting from age, rather than to the primary capacity to learn.

TABLE I
RELATIONSHIP OF AGE TO VARIOUS ABILITIES

No decline or rise with increased age in	Sensori-motor ability until age 50
	Memory for simple materials
	Rote memory until age 70 or more
	Reasoning by analogy until age 30
	Tonal memory
	Vocabulary
	General information
	Reasoning by analogy until age 60 in high ability groups
Some progressive decline in	School subjects
	Typewriting
	Addition and arithmetic
	Analogous reasoning after age 30
	Imaginative thinking
	Motor speed
	Object assembly, block design
	Similarities and comprehension sub-tests
	Wechsler Intelligence Scale
	Reasoning by analogy in average ability groups
Greatest decline in	Recall of new materials
	Sensori-motor ability after age 50
	Rote memory after age 70
	Code learning
	Associating numbers with nonsense syllables
	Reasoning by analogy in low ability groups after age 30

After Garry and Kingsley

The most pronounced impact of physiological changes upon learning occurs with respect to the element of *speed* or mental facility rather than *power* (Bischof, 1969; Donahue, 1955). Thus, the decline in visual and auditory acuity or in strength and flexibility increases the amount of time required to learn or to perform but does not alter an adult's ability to learn.

Although the effects of age are more conspicuous among older adults, this is merely a matter of degree because all adults are aging. Consequently, every instructional situation for adults must take into

account the impact of age-based changes upon learning and instruction. Older adults will require certain kinds of considerations because of the more pronounced influence upon them of aging, but younger adults are also aging even though they may not require as much adjustment to accommodate learning.

While the physiological condition of the individual adult is beyond the influence or manipulation of an instructor, the learning situation itself contains elements that are amenable to modification. The design of the instructional process, the selection of learning tasks, the rate at which instruction occurs, and the nature of the instructional setting may all be modified by the instructor to accommodate the variable physiological conditions of the adult learner. These elements will need to be adapted in different ways for adults of different ages.

In general, few adults are aware of the nature and scope of the physiological changes that result from aging. Consequently, they are less able to adapt to change and more apt to experience anxiety or depression when change occurs. Instructors in adult classes have an important and significant opportunity to help adults adjust. By helping them understand the aging process and to recognize changes as they are occurring, an instructor can help to reduce the psychological impact of physiological changes. To do so, instructors themselves need to be aware of the aging process and to apply this knowledge in the design and management of adult learning situations.

III. VISION

Adults with normal physiological characteristics depend more upon vision in learning than upon any other of the senses. It is estimated that some 85 percent of all learning occurs through vision; consequently, visual acuity is a matter of utmost importance for adult education. Although the life span of the eye exceeds life expectancy, there is a steady decrease in the average efficiency of visual functions with advancing age, even in otherwise healthy eyes. As a result, the percentage of the population with defective vision shows a sharp increase from 23 percent at age twenty to 95 percent at seventy years of age (Table II).

TABLE II
ESTIMATED PERCENTAGE OF THE POPULATION WITH DEFECTIVE VISION

Age	Percent Defective
20	23
30	39
40	48
50	71
60	82
70	95

Adapted from Luckiesh

Visual acuity is not simply a single function but rather a variety of different kinds of visual performances that may change at different rates and affect learning and instruction in different ways. Therefore, it is useful to examine the changes that occur in visual performance, but in order to do so it is first necessary to examine the physiological changes that occur in the eye.

THE EYE

The eye of an adult weighs approximately one four-thousandth part of the total body weight and its diameter is slightly less than one inch. Until a person reaches about twenty years of age the eye is growing and developing but beyond twenty it begins to age. This tiny organ is composed of many separate parts and each part is affected differently by the aging process. The chief components of the eye are the *iris*, the *pupil*, the *lens*, and the *retina* (Graham, 1965).

The *iris* contains pigment in varying quantities which give color to the eye. It is made of a delicate ring-shaped sheet of muscle consisting of two sets of fibers: one set is arranged in a circle and the other set radiates from the central visual opening which is known as the *pupil*. When the circular fibers contract like a purse or draw-string, they cause the pupil to contract or narrow. When the other fibers contract, the pupil widens or dilates. These fibers control the amount of light entering the eye so that in dim light the diameter of the pupil is greater than in bright light. The iris loses some of its pigment as age advances and the pupil loses some of its ability to control the amount of light that enters the eye.

The *lens* is a convex transparent body through which light passes when it enters the eye. It is controlled by muscles that can alter its shape to facilitate the correct focusing of external images on the retina. For close objects, the lens thickens into a more curved or bulging shape and flattens progressively as the distance of the object increases. The lens becomes less elastic with age, thereby losing some of its ability to maintain the correct focus required for clear vision. In addition, it also tends to yellow, which reduces somewhat the amount of light entering the eye, as well as acting to filter some colors.

The *retina* is located at the back of the eye and receives the light which enters through the pupil. The retina is composed of two groups of light sensitive cells known as *rods* and *cones*. The *rod cells* enable us to see at night, while the *cone cells* are useful under high illumination. The cone cells also play an important role in color vision.

Light enters the eye through the pupil and then continues through the lens where it is focused upon the retina. The action triggers electric impulses which are conducted via the optic nerve to the brain, where the visual stimuli are finally perceived and interpreted. The aging process affects each stage of this procedure.

VISUAL ACUITY

The healthy and proper functioning of these various components of the eye determines one's *visual acuity* (Graham, 1965). Such factors as age, disease, injury, or diet may produce some malfunction in the eye which will affect its ability to focus, to respond to illumination, and to detect color. If the eye's response to visual stimuli is blocked or at least retarded, the adult's perception is ultimately altered.

The distance from the eye at which an object can be seen clearly is known as the *near-point of vision*. The near-point of vision begins to move away from the eye after ten years of age and the most striking

change occurs between forty-five and fifty-five years of age (Table III). At this time many individuals require glasses for reading and other close work. Adults often resist getting glasses because of vanity or some notion about resisting the effects of aging. Instructors need to be aware of the change in the near-point of vision in the normal eye as it may be the source of learning difficulty.

TABLE III
AGE AND NEAR-POINT OF VISION

Age in Years	Near-point of vision in inches
10	2.8
20	3.3
30	5.0
40	9.0
45	11.0
50	16.0
55	22.0
60	40.0
65	53.0
70	160.0

Adapted from Perera

The *far-point of vision* identifies the capacity to distinguish distant objects. At the same time that the near-point is moving away from the eye, the far-point is moving in closer—although not quite so noticeably. These two actions together impose restrictions on the range of clear vision as objects neither too close nor too far away can be seen distinctly.

The distance factor in visual acuity results from changes that occur in the lens of the eye which must accommodate its shape to the distance of the object to be observed in order that the resultant image may be clearly focused on the retina. With advancing age the lens loses its elasticity and cannot focus readily.

At the same time that the lens is losing its flexibility the muscles that control the lens are losing something of their power. This results in an increase in the time required to change focus from near to distant objects or distant to near objects. In younger people the time required for this operation is about two seconds, while in those adults forty or over some three seconds or more are required to change focus (Birren, 1959; Birren et al., 1959; Bischof, 1969; Graham, 1965). This helps to

explain some of the increased time to accomplish a learning task that is characteristic of adults. Three seconds may not sound like much time but imagine how it adds up as an adult attempts to copy something from the blackboard.

Variability to Illumination

The muscles which control the size of the pupil lose some of their power which limits the ability of the pupil to open wide enough to admit sufficient light to enter the retina. The average pupil in the normal eye will admit only about one-half as much light at age fifty as at age twenty. This is further accentuated in relating day to night vision. At age twenty the difference in pupil size between day and night is 3.3 millimeters but at age sixty it is only 1.0 millimeters (Table IV). Thus, vision is severely restricted by the progressive inability of the pupil of the eye to admit sufficient light.

TABLE IV
EFFECT OF AGE ON THE DIAMETER OF THE PUPIL IN MILLIMETERS BY DAY AND NIGHT

Age	Pupil Size in Daylight	Pupil Size at Night	Difference
20	4.7	8.0	3.3
30	4.3	7.0	2.7
40	3.9	6.0	2.1
50	3.5	5.0	1.5
60	3.1	4.1	1.0
70	2.7	3.2	.5
80	2.3	2.5	.2

Adapted from Nitsche and Gunther

It is possible to compensate for the changes in pupil size by increasing the amount of external illumination. For a normal learning task an adult at age twenty requires 100 watts of illumination, but by age fifty 180 watts are required for the same task to compensate for pupillary changes (Table V). The nature of the task will affect the amount of illumination required. Coarse work requires less light than fine detail work.

TABLE V
THE PROGRESSIVE INCREASE IN WATTAGE REQUIRED FOR VISUAL TASKS

Age	Wattage Required
20	100
30	120
40	145
50	180
60	230
70	300
80	415

Adapted from Luckiesh

Merely increasing the amount of light does not resolve the difficulties arising from pupillary changes. Too much or the wrong kind of light may produce visual discomfort and reduce visual efficiency through *glare* (Graham, 1965). Glare is misplaced brightness that results from the reflection of light back into the eyes from objects in the environment. Glare affects vision because the eye tends to be attracted to the brightest spot and if this is not the learning stimulus, then it is difficult for the adult to center attention on the task at hand. Furthermore, glare raises the level of brightness of the background so that it becomes difficult to distinguish detail. Thus, efforts must be made to insure that glare is reduced and that the learning stimulus receives the principal illumination.

Another important aspect of illumination is the matter of *contrast*. The learning task or stimulus must be set apart from its background so that it stands out as separate and distinct from its surroundings. Contrast has a pronounced effect upon the speed and ease of reading. Reading is reduced significantly when the words read are not in sharp contrast with the paper on which they appear. Newsprint is generally a dull gray color and words printed on it are difficult to distinguish. Increasing the illumination and centering it on the material can help overcome poor contrast but this is, at best, a temporary measure. The size of type used in printing reading materials for adults will influence contrast. When the size of type is 10-point on a 12-point base, more white space surrounds each letter, thereby increasing the contrast between the printed matter and the paper. Inexpensive reproduction processes, such as mimeograph or ditto, should be avoided. If the use of such processes is unavoidable, then the material should be typed with double-spacing and pica type and the machine heavily inked to increase the contrast. The kind of paper

that is used is also important. Papers with a hard glossy texture will increase glare as will glossy inks. On the other hand, dull papers such as newsprint will reduce glare but also reduce contrast. A matte white paper with dull black ink will strike a compromise between glare and contrast.

The most common instructional device is rarely used with any thought to its impact upon visual acuity. Chalkboards are indispensable but when they are not used properly they increase glare, reduce contrast, and increase visual difficulties. Glare reflecting from a chalkboard can obscure the material written on it. A dirty board from which the chalk dust has not been removed reduces the contrast between the material and the background. Messy chalkboards covered with miscellaneous material make it difficult for the learner to center attention on the particular task at hand and writing that is too small cannot be seen clearly by all members of a learning group. The source of light or the position of the chalkboard may need to be adjusted to reduce glare. A dry eraser merely spreads the chalk dust rather than removing it, so a damp cloth should be used to maintain a sharp contrast. Boards should be cleaned as soon as the material is no longer needed and before new material is applied, so that elements of an earlier learning task do not distract the concentration of the learner from the new task. Finally, written material, diagrams, and such should be large enough to be clearly visible by every learner.

Color Perception

The perception of colors adds enormously to the richness of visual experiences as well as to the amount of information available (Graham, 1965). Color sensitivity shows a gradual loss due to the yellowing of the lens which acts much like sunglasses and filters the blue end of the spectrum. After age thirty-five more blue light is needed to get a sensation of blue. This loss of yellow-blue discrimination occurs first, but loss in color discrimination diminishes as one moves toward the red end of the spectrum and there is no appreciable loss in red-green discrimination. Thus, after age thirty-five, learning tasks involving color will need to use strong rather than subtle tints. Color can also aid in reducing visual handicaps by providing contrast. Brightly contrasting colors can help to reduce the hazards of poor illumination that might occur in such places as on the edges of steps or over the parts of a machine. Color can be used to enhance a learning stimulus. Charts and diagrams will become more meaningful to the learner when a sharp contrast of colors accentuates the specific information the learner should acquire.

There is no relationship between color vision and intelligence but there is a relationship between color discrimination and use. An artist is

not as likely to lose his color discrimination as quickly as someone who does not use color constantly. Furthermore, a person with exceptionally good color vision will show less loss of discrimination than will one who did not have good color perception initially.

VISUAL PERCEPTION

Visual perception is the conscious mental process through which an individual becomes aware of a visual stimulus. In this process a visual stimulus is received in the brain, coded, and stored in the short-term memory (Graham). If the stimulus is already known, it will be discarded; but if it is a new experience, it may be re-coded and transferred to long-term memory storage. With youth there is more likelihood that a stimulus will be unfamiliar and, therefore, processed in the brain, but adults are perceptually more distant from their environment by virtue of experiences with it. Limitations imposed by physiological changes often result in a lessened opportunity for adults to perceive stimuli.

In the learning situation the crucial stimuli must be emphasized and exposed to the adult learner over a longer period of time. Elements such as illumination and contrast are applicable in this situation. The correct perception of the stimulus will be affected by the clarity of the presentation, by any confusion surrounding the stimulus, and by any ambiguity which may exist. Once the adult has formed a perception of a stimulus, it is difficult for him to change his mind. Therefore, it is important that the learning stimulus be presented in such a way that the initial perception of it by the learner is correct and functional.

IV. HEARING

Hearing is the second most important sensory access to the brain. Although it is estimated that only ten percent of learning occurs through hearing, vision and hearing are complementary in that each enhances the stimulus perceived by the other. An adult confronted with a steady decline in visual acuity will usually use hearing to supplement vision automatically or vision to supplement hearing, as the case may be. Loss of hearing is usually so gradual that few individuals will notice any decrement. Maximum audio acuity is attained between ten and fifteen years of age after which there is a gradual but consistent decline to about sixty-five years of age.

THE EAR

Hearing is accomplished through the ear, which consists of three main divisions: the outer, middle, and inner ear. The outer ear is that part of the anatomy which we see and call the ear and the channel leading inward to the middle ear. The *pinna*, or outer, visible part of the ear, functions as a protective device to scatter sound, rather than to gather and focus sound, as one might think. Since not all sound is deflected, some of it enters the channel leading to the ear drum. This channel or *meatus*, warms the air and has a ring of hair to trap dust and insects. The surface is lubricated by ear wax. The incoming air which carries the sound is maintained at a fairly constant temperature to protect the *ear drum*. This is a delicate translucent membrane about one three-thousandth of an inch thick that separates the outer from the middle ear.

The middle ear is filled with air and is connected to the mouth by the *eustachian tube* which acts as a pressure equalizer. Sound waves strike the ear drum and are transmitted across the inner ear through three articulated bones popularly known as the *hammer*, *anvil*, and *stirrup*. The vibrations created by the sound waves acting on the ear drum are transmitted to the inner ear by these three small bones and in doing so they act as an automatic volume control that protects both the ear drum and the inner ear from high intensity sound damage.

The sound waves cross the middle ear to the *oval window* in the inner ear where the vibrations are transferred to the fluid that fills the *cochlea*. It is in the cochlea that the sound vibrations are converted into nerve impulses and transmitted to the brain. After this, the sound waves pass back into the air-filled middle ear and out again into the atmosphere through the mouth. This complex structure of the ear is designed to protect man from excessive noise damage.

AUDITORY ACUITY

Auditory acuity identifies a person's ability to receive sound (Canfield, 1960). A unit of measurement called a *bel*, which is normally used in units of ten, or a *decibel*, is the measure of auditory acuity. This is used to measure the loudness of sounds as well as the degree of loss in the ability to hear. When the loss in hearing exceeds the decibel loudness of ordinary sounds, a person will be unable to detect or receive the sound. A quiet whisper measures 15 decibels; ordinary conversation is 60; and an average classroom measures 60 decibels; discomfort from listening to loud speech measures 100; and a painful noise reaches 130 decibels. In general, there is a progressive loss in acuity for pure tones with each succeeding decade of life. Men show a greater overall loss than do women, who tend to lose the ability to hear low tones first while men lose high tones first.

Defective hearing does not affect as large a proportion of the population as does defective vision. At ages 10 to 19 some eleven percent of the population are estimated to have defective hearing. This increases gradually to 51 percent at age seventy compared to 95 percent with defective vision. Beyond 65 years of age, the progress of hearing loss varies with each individual.

Losses in auditory acuity result from three basic sources: (1) the loss due to normal physiological aging or *presbycusis*; (2) changes resulting from normal wear and tear; and (3) hearing loss induced by the nature and conditions of employment (Birren, 1959; Birren et al., 1959; Canfield, 1960).

The normal process of aging produces physiological changes in the ear that reduce the ability to discriminate among sounds. This causes an impairment in speech discrimination in which the sound of the voice may be heard but it may be difficult to distinguish separate words, and certain consonants like V, D, B, and TH, will be confused. Sounds may not be heard that are normal in the environment such as a telephone bell, the singing of birds, or a child's voice.

To compensate for normal hearing loss in an adult learning situation, it is important that the instructor speak slowly and distinctly and with sufficient volume. Unfamiliar or confusing words and phrases should be avoided. New terms or numbers should be written on a chalkboard so vision can be used to supplement hearing. Since loss of hearing reduces the ability to recall long sentences, an instructor should use short sentences—particularly when giving directions for learning.

Hearing loss resulting from normal wear and tear, as well as from employment, stems from *noise* in the environment (Birren, 1959). The exposure to high noise levels for long periods of time produces a per-

manent loss of auditory acuity. Adults from rural areas show less loss of hearing than do those in urban areas. Rural adults show a mean hearing loss of 18 decibels at age 55 to 64 compared with a loss of 45 decibels in the same age group resident in an urban environment.

A noisy environment will have a pronounced effect upon learning as it will obscure or block verbal communications used in learning and instruction. Furthermore, noise will interrupt the learner's attention, which can result in a critical disturbance of the short-term memory mechanism at a crucial stage in the learning process. Noise also may block the adult's reception of directions for learning or cause him to miss crucial information. Many apparent failures in learning may result from the interference of environmental noise.

Noise is not always something that an instructor can control. In an urban setting, it is difficult to avoid environmental noise, but administrators scheduling the use of space for adult classes can select rooms that are somewhat protected from street noises. Instructors can be careful not to attempt to talk with the group as a whole when outside noise is excessive. In shop classes, for example, machinery and equipment should be stopped during periods of class instruction.

Another source of noise is that of *echo* or the reverberation of sound from hard surfaces such as walls. This is similar to the problem of glare in vision. Echoes will produce noise but the principal impact is from the imperfect and incomplete repetition of the original sound. Ordinary school classrooms generally have little sound absorption material so the problem of echoes may be difficult to avoid. The human occupants of a room do provide good sound absorption, so small classes should be held in small rooms to reduce the effects of echoes.

AUDITORY DISCRIMINATION

For most individuals, the ability to *discriminate* and to comprehend sound is more crucial than the ability to detect sound (Canfield, 1960). Through the ability to discriminate, it is possible to distinguish voices from background noise, to know one voice from another, and to differentiate one word from another. Thus, in addition to the ability to detect sound, there must also be *intelligibility*.

The concept of intelligibility refers to the ability to attach meaning to sounds. This is particularly applicable to the sound associated with speech. Speech sounds have different frequencies, intensity, and duration which influence the intelligibility of speech. Physiological changes in hearing affect an adult's ability to discriminate among the different speech sounds, so the greater the decline in the receptivity of sound, the

greater the loss of power to discriminate and the greater the difficulty in comprehending speech.

The ability to comprehend the spoken word is reduced by the presence of *masking* sounds. These are sounds that cause the primary sound to become less audible, as when a room full of people in conversation tends to drown out any conversation. In a learning situation where much of speech may involve new and unfamiliar material, masking can become a real barrier to comprehension. In older people, the ability to comprehend the spoken word is reduced markedly by masking sounds where an "overload" situation develops. This creates confusion so that older adults may be unable to maintain attention, perceptual discrimination, or the organization of the material.

When managing instructional activities for adults, it is necessary to keep masking sounds to a minimum in the classroom. The 60-decibel level of ordinary background noises in a classroom is too high for effective conversation and the noise interference level should not rise above 25 decibels. As noise interference increases, discrimination and comprehension decrease (Table VI). One of the most effective ways of reducing masking sounds is by making adults aware of the source and consequences of background noise. Adults will understand the barrier to learning created by conversations in the learning situation that are too loud and they will be cooperative in reducing the noise level when this is explained to them.

TABLE IV
MAXIMUM PERMISSIBLE NOISE LEVELS FOR COMFORTABLE SPEECH RECEPTION IN DIFFERENT KINDS OF ROOMS

Type of Room	Maximum Noise Level in Decibels
Small private office	40
Conference room for 20	30
Conference room for 50	25
Movie theatre	30
Theatre for plays	25
Concert hall	20
Secretarial offices (typing)	55
Home (sleeping area)	25
Classroom	25

Adapted from Jones

Emotion and Hearing

The inability to hear clearly and to comprehend satisfactorily can produce emotional disturbances such as depression, anxiety, or frustration. Where such disturbances have developed in an adult, learning cannot be achieved until these problems have been brought under control. Hearing aids appear to have some degree of social stigma attached to wearing them and thus may accentuate rather than alleviate the emotional disorders associated with defective hearing.

An adult's ability to hear and comprehend is affected by his own perception of his ability. Although emotion does not impair the ability to detect sound, it will affect attention to the sound, the ability to discriminate among sounds, and comprehension. An adult can control his listening attention in such a way that he hears what he wants to hear, thereby protecting himself from unacceptable material. Words that are repugnant, such as obscene words, or material that is perceived as threatening can be avoided through selective listening attention. Furthermore, if an adult lacks confidence in his ability to successfully complete a learning task, this may affect his perception of the audio stimuli associated with the task, including directions from the instructor. On the other hand, if an adult is unable to understand a task, he may feign deafness to protect his ego.

An inability to hear and to comprehend will create tension and anxiety in the learner that further inhibit hearing. As acuteness of hearing declines, it is accompanied by a decline in the speed with which the individual can discriminate and comprehend.

Instructors can do much to reduce the effects of emotional factors by reducing masking sounds and by presenting audio stimuli that are distinctive and understandable. The internal security of the learner who has a lessened audio acuity can be strengthened when an instructor is sensitive to the problem and compensates for it by gaining attention before giving directions, by repeating directions clearly and audibly, by reducing masking sounds, and by presenting the learning tasks in smaller units. Furthermore, an instructor should avoid excessive or verbose directions for learning since this may confuse the essential elements in the directions. Stimuli that are meaningful to the learner will be perceived more readily. Therefore, an instructor must select the stimulus carefully and establish its meaningfulness to the learner either in terms of what has been learned or as a prerequisite to future learning.

V. LEARNING

Learning is a more or less permanent change in behavior that occurs as a result of activity or experience. It is a *process* that occurs in the mind of the learner and is not itself observable. The result of learning may be observed by what an adult says or does that reflects the learning. Physiological factors will influence the learning process by the ways they affect perception and interfere with the transmission of learning stimuli to the mind. They will also affect the ability of the adult to perform or demonstrate that learning has occurred. Thus, an adult may lose some facility that results in a poor performance, but this does not necessarily mean that learning itself has been poor.

PERCEPTION

Certain fundamental changes will occur in the basic sense organs which reduce *sensory acuity* so that an adult becomes less aware of such simple stimuli in his environment as sound, color, taste, or odor. This, in turn, affects an adult's *perception*, which is his ability to discriminate among stimuli and to process them so that they become meaningful (Bischof, 1969). A reduction in sensory acuity necessitates a strengthening of the stimuli in order for them to be perceived by the adult. Thus, the sound must be louder, the colors brighter, and the odor or taste stronger in order that they can be perceived.

In learning, an adult is presented with a stimulus to which he responds selectively, and then processes until it is ultimately stored in his short-term memory. The successful completion of this process is largely dependent upon his physiological state. As changes occur, it becomes increasingly difficult for the adult to perceive the stimuli in the learning situation; hence, he develops a less intense attentional set and can no longer handle a mass of sensory material with speed and minimum of error. At the same time that he loses the ability to focus adequately upon various stimuli, he also loses the power to maintain attention over a long period of time.

The changes in sensory acuity that result in reduced perception cannot be altered, but an instructor can take some action as compensation. He can help an adult understand that his sensory acuity is reduced and that he must attend to the stimuli more carefully when it is presented. In addition, an instructor's use of any novel or intense stimulus situations that tend to attract and focus attention should result in some benefit to the learner. The use of verbal directions such as "watch this," increased illumination on the stimulus object, bright colors,

or increased volume of sound will all serve to catch and hold the attention of the learner. Since an adult is unable to maintain attention over long periods of time, there will need to be frequent repetitions of the stimulus when it is obvious that the learner's attention is no longer centered on the task.

Regardless of how simple the learning task may appear, it is always a complex task for the learner. Reduced sensory acuity will increase the amount of time required to perceive the task adequately. In observing a demonstration, the adult will be unable to follow the process demonstrated if it is conducted too quickly for him to observe and relate all the separate materials and actions that are included. In looking at a rock, for example, an adult must have sufficient time to give adequate attention to its size, shape, color, or texture and to process the information as he receives it. In any case, the stimulus will have some features that must be perceived and stored, as well as some that are to be ignored as the learner reacts to it. As the number of relevant and irrelevant elements are increased by the complexity of the task, the learner's ability to discriminate among the elements and select those that are important is reduced. Thus, when physiological factors intervene, the learning task must be simplified which may mean that a task must be divided and arranged into a sequential series of sub-tasks. In reading, for example, older adults cannot handle as many new words at one time as can younger adults and the comprehension of the material read is similarly reduced.

Attention to a learning stimulus usually involves one sensory experience more than another. Where it is possible to present an identical stimulus through more than one sense organ *simultaneously*, the signals will support each other and attention will be improved. By presenting a new word visually and orally at the same time, the learner's perception of the word is enhanced. This occurs only when the same information is presented to both senses simultaneously. When one bit of information is presented visually and a different bit is presented orally at the same time, one or the other will be ignored because the learner cannot concentrate his attention on both and receive different information from each one simultaneously. In conducting a process demonstration, therefore, an instructor must be careful to insure that the verbal information that accompanies the visual material is identical rather than different information. Younger adults are better able to cope with two stimuli in this manner than are older adults whose capabilities to perceive and process information are reduced by age.

To some extent, an instructor can accommodate perceptual changes by the use of directions preceding the presentation of the stimulus. He can advise the learner regarding aspects of the new material he should

attend to and what he may ignore. In presenting similar words such as *pit, put, pat, pet,* he can direct the learner's attention to the differences in the middle letter of each word. By being alerted to certain points about the learning task before it is presented, the learner will be able to concentrate on the crucial elements of the task and thereby increase his comprehension. Here again, the matter of the speed of presentation is important as the learner will require time to process the directions before actually encountering the learning task. In effect, the directions provided by an instructor are themselves a learning task which must be mastered before the learner proceeds to the task to which the directions apply.

MEMORY

The physiological condition of the learner may cause some impairment of memory, but poor initial learning is more likely to be the cause of poor memory than is physiological condition. There is ample evidence to indicate that loss of memory function may be reduced by altering the conditions in which the learning occurs originally. The most crucial factors in the original learning appear to be the element of time, the complexity of the learning task, the sense organs through which the learning stimulus is presented, the arrangement of the learning activity, and the conditions in the learning environment. These factors are influenced by the learner's skill in handling the learning process and by the time he requires to consolidate new learning in order to store it in his memory system.

Adults who are inexperienced in learning, or who have not engaged in learning for a long time, will be less able to handle the learning process and will need to proceed more slowly than those who are more experienced. Given adequate time, an adult learner can manage learning so that he is able to transfer the new material to his memory system and to establish a *memory trace* that is strong enough to survive. Since an instructor is unable to determine the precise time requirement of each adult to complete the learning operation, it is desirable to encourage self-pacing whereby the learner can set his own time.

Since adequate perception of the learning stimulus is a prerequisite of learning and, consequently, of memory, an instructor can enhance the retention of learned material by insuring the accurate and complete perception of the stimulus. Older adult learners appear to be more susceptable to interference than are younger adults. The activities that occur immediately prior to learning (*proactive inhibition*) or between the period of learning and the use of the learned material (*retroactive inhibition*) interfere with the retention of the learned material more and

more as age advances. Thus, each period of learning activity should be preceded and followed by a period of rest. Older adults experience particular difficulty in short-term retention when they have to absorb a certain amount of information and hold it for a few seconds while doing something else. They tend to give their attention to one thing at a time and appear unable to cope adequately with several things simultaneously. In view of this, the arrangement of the learning situation and the sequential ordering of learning activities is crucial to retention.

Since an adult's self-concept is shaped, in part, by his response to his physiological condition, this may produce apprehension about learning and a sense of inferiority that ultimately interfere with the storage of learned material in the memory system. Adults are usually acutely aware of memory failure and this creates anxieties that block memory even more. It is difficult to overcome these kinds of emotional blocks; successful achievement in learning is about the only way to do so. Instructors can plan learning activities to insure success and, through their own supportive attitudes toward the adult learner, can instill confidence and counteract any negative attitudes the learner may develop.

AGE AND INSTRUCTION

Not only do learning activities designed for adults differ from those for children, but also those for older adults must be planned differently than those intended for younger adults. Younger adults can handle more complex learning tasks in less time, while older adults usually require considerably more time. As the age of the adult learner increases, the simplicity, intensity, and frequency of presentation of the initial learning stimulus must also increase to compensate for loss in sensory acuity. Changes in attentional set resulting from age necessitate the simplification of the learning task so that the older adult can concentrate a greater use of memory clues in order to trigger the recall of previously learned material. Instructional techniques must be specific and simple so that the attention of the older adult can be centered upon the most relevant elements of the learning task. The instructor must strengthen the confidence and expectations of success in older adults to overcome the influence of negative attitudes about their own ability to learn. Older adults should set their own pace for learning and not be pushed by an instructor in an effort to keep all members of the learning group at the same level.

VI. PERFORMANCE

Although learning itself is not observable because it is a process that occurs in the mind of the learner, the results of learning can be observed through *performance*. Performance is the end *product* of the *process* of learning as it demonstrates what has been learned. Because performance is an activity by a learner, physiological factors may affect the proficiency of performance (Birren, 1959; Birren et al., 1959; Bischof, 1969; Donahue, 1955; Welford, 1968).

The major physiological changes that affect performance are those that occur in the nervous and muscular systems (Birren et al.). In the nervous system there is a gradual loss of nerve cells, reduced neutral excitability, and physiochemical changes that reduce the speed with which messages are transmitted through the central nervous system. Changes in the muscular system include reduced strength and power along with loss in agility and flexibility. These changes ultimately result in a slowing of the speed of performance and imposed limitations upon the various kinds of activities which an adult can perform with any degree of skill or confidence.

At the same time that performance is being altered by physiological changes, it is also being affected by the emotional response of an adult to physiological change. Thus, physical changes are often accentuated by the emotional state they induce. As an adult becomes less confident of his own ability, he may take longer to perform familiar tasks than his physiological state alone would require. This is apt to occur particularly in those situations in which inaccuracy or incompetency would have serious consequences for the individual, i.e., his performance on the job. Some adults might respond to a decrease in the ability to perform efficiently by increased motivation and determination to compensate for the loss, while others may become depressed and discouraged to the point that their performance falls far below the potential of their actual physical state.

Although physiological factors affect all kinds of performance, those related most closely to learning and instruction are psychomotor skills and verbal communication.

PSYCHOMOTOR SKILLS

The satisfactory performance of tasks involving psychomotor skill is directly affected by the physiological condition of the individual. The performance of a psychomotor skill is an organized and coordinated activity that involves the sensory, nervous, and motor mechanisms.

Within the overall pattern of the skill, many different actions are ordered in a specified sequence in time. Proficiency in the performance of the skill requires that the necessary actions be done in the proper sequence in a minimum amount of time. Such proficiency in performance is acquired gradually after repeated practice or experience in performing the sequence of actions. Loss of proficiency occurs when something persistently interferes with or reduces the action, thus increasing the time required.

Individuals will vary in terms of the rate at which they acquire proficiency. Similarly, there are individual differences in the rate at which proficiency of performance is lost. Both the acquisition and loss of proficiency are due to individual differences in perception, coordination of muscular movements, dexterity, and to the speed at which these functions occur (Welford, 1968).

Young adults tend to acquire increased speed of satisfactory performance through increased experience with the skill, but this does not insure that speed of performance can be maintained through experience alone. The conditions that govern speed in psychomotor performance include the complexity and strength of the stimulus, familiarity with the task, attentional set, the complexity of the appropriate response, and the age and condition of the individual performing. Thus, regardless of the speed of performance achieved earlier, there will be a decline in speed because of the ways that age-based physiological changes interfere with the elements that make up performance.

Speed of performance is also affected by changes in both *reaction time* and *movement time*. *Reaction time* is a measurement of the interval of time that elapses between the presentation of a stimulus and the response to it. This is the time required for the stimulus to be perceived in the brain, for the appropriate response to be selected, and for directions to be transmitted from the brain to the appropriate muscle. After the message has reached the muscle, there is a further lapse of time, called *movement time*, until movement occurs. Changes in the central nervous system may delay or impede the transmission of the stimulus and response so that reaction time tends to increase. At the same time, changes in the muscular system may reduce agility and strength so that there is also an increase in the movement time required. Thus, older adults cannot perform at the same speed as younger adults, but changes in the speed of performance are gradual and hence speed is reduced only gradually as age increases.

An instructor cannot compensate for the loss in speed resulting from physiological changes in the adult learner, but he can insure that the optimum conditions for learning are present so that an adult can achieve

his potential. This can be done by insuring that the learner receives and recognizes the stimulus, by increasing the time allowed to perceive and consider the stimulus, by encouraging the adult to self-pace his response, and by providing immediate knowledge of results. When such conditions are established in the learning situation, an adult should succeed in acquiring some proficiency in skill performance in spite of physiological barriers.

There are some psychomotor skills that should not be attempted by some adults; therefore, an instructor has a crucial role in counseling adults about what to attempt, particularly if it is related to training or retraining for employment. An older person is not likely to achieve a sufficient level of proficiency in operating a typewriter to enable him to compete for a job against younger adults. Furthermore, adults who have had no prior experience in learning complex manipulative operations will often encounter difficulty when attempting such learning in later life. Thus, the physiological condition and potential of the older adult must be a prime consideration in counseling for learning and employment.

VERBAL COMMUNICATION

The ability to communicate through speech or writing and to receive communications through reading or listening are crucial functions in the modern world. Among people of all ages may be found disorders of speech, hearing, or language that will affect performance.

Speech

Under normal conditions adults will rarely show changes in speech patterns until quite late in life; nevertheless, there is a gradual alteration in certain aspects of speech as age advances. The rate of speech tends to slow down and there is often some hesitation in finding the right word, especially if the word desired is one used infrequently.

Changes in the voice occur gradually due to a decrease in elasticity and a hardening of the laryngeal cartilages which becomes evident at about age forty. In the thirties and forties vocal pitch is lower than in early adult life but after the forties it becomes gradually more highly pitched (Birren, 1959; Bischof, 1969). In senescence the voice tends to become high and piping, less powerful, and restricted in range. Singing and public speaking which make greater demands upon vocal capacity show deterioration earlier than do normal speaking voices, but training in voice pitch and placement will result in the retention of these skills for a longer period of time.

Hearing loss influences speech. This stems from the fact that the

speaking voice is partially controlled by what an individual hears of his own voice. Some people with hearing loss speak louder but some speak in a softer voice and this may provide a clue to hearing loss not otherwise observed.

Verbal Fluency

The number of words known by both recognition and recall increases with age, but the speed of recognition or recall is reduced. The amount of reading and listening seems to remain about the same throughout adult life, but the type of material varies. At the same time, the amount of writing declines. Although most research shows an increase in vocabulary and information as age advances, physiological changes will affect an adult's ability to use what he knows efficiently. Adults tend to change the ways in which they organize and use the information which they accumulate. There is a tendency to encompass larger amounts of information under broader concepts and to apply information through generalizations that are more firmly set.

Many adults are inhibited from active participation in discussion by a lack of confidence in their own ability. This can be accentuated when hesitancy is falsely interpreted as inadequacy rather than being recognized as the result of physiological changes in the speech mechanism. Wide disparities in age within a group will tend to increase the older members' lack of self-confidence as they see the ease and facility with which younger members participate. Furthermore, older members will tend to think less rapidly, experience difficulty in maintaining attention, have trouble in finding and using words for effective expression, and they will usually experience an impoverishment of ideas.

The subsistence life style of the disadvantaged may result in generally poor health and little reserve of energy (Anderson & Niemi, 1969). Since physical well-being has been found to be directly related to verbal intelligence and facility, the disadvantaged adult at any age can be expected to show significantly lower speech performance levels than his more advantaged counterpart. The verbal fluency of the disadvantaged adult is influenced by the impoverished cultural environment in which he lives. This usually results in a limited vocabulary for listening as well as speaking. The paucity of enriching experiences in life from which an adult accumulates information may reduce a disadvantaged adult's ability to handle unfamiliar ideas and concepts. It might also be more difficult for an instructor to make new material meaningful because of the lack of previous information to which it can be related.

Instructional programs for the disadvantaged can provide enriching experiences to compensate in part for the poverty of the environment.

Through these experiences, the vocabulary and information levels of the adult can be raised appreciably. This aspect of instruction may be far more important for and rewarding to the disadvantaged than the usual school-based content which he cannot handle easily because of the lack of the prerequisite vocabulary and information.

VII. SUMMARY

Successful achievement in learning and proficiency in performance are affected by the physiological condition of the adult learner. This condition may stem from accident, illness, malnutrition, or other experiences in the life of an adult but the most pervasive and universal source is the normal process of aging. Adult educators often unwittingly accentuate the difficulties arising from the physical condition of the learner by the ways in which they manage instruction and by the conditions established in the learning situation.

Because vision and hearing provide the major access to the mind for learning stimuli, instructors need to be particularly sensitive to difficulties related to these senses. Every adult learner will experience some deficiency in auditory or visual perception but this need not be an insurmountable barrier to learning. Alterations in the conditions of learning and adjustments in instructional processes can reduce the interference with learning arising from deficiencies in vision and hearing.

Physical difficulties often give rise to emotional states that inhibit effective involvement in learning. This effect can be reduced when an adult educator helps the adult learner understand the nature of his difficulty and the ways of overcoming its interference with learning. Furthermore, by judicious counseling, an adult educator can help an adult select learning objectives appropriate to his physical condition.

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